BIOTECHNICS

By G. H. SCHWABE

As those who have read Dr. Schwabe's previous articles in our magazine know, he is a natural scientist who on the one hand is enthusiastically devoted to his research work but, on the other, has not lost touch with the world's happenings. The more the general trend toward a combining of the various branches of science makes itself apparent, the more deserving of interest are ideas such as are contained in the following article.—K.M.

NATURE and mind, life and machines, seem to have become more and more opposed in the course of modern history. Civilization is to a certain extent still doing its best to provide man with an artificial, unnatural environment. His dwelling has an artificial climate that is milder and more temperate than that of nature; but he has to pay for his increased comfort with an increased susceptibility to the raw conditions of nature. Our advanced hygiene has almost completely wiped out the epidemics which in former times often altered the course of history; but death as man used to know it, from one of a limited number of diseases, has now been replaced by a multitude of afflictions of all kinds. Cancer, diseases of the heart, occupational diseases, and diseases directly attributable to civilization occur with growing frequency. Technical knowledge which, on the whole, was developed by the desire to enhance the enjoyment of life and to increase comfort as well as the protection from danger, simultaneously produced means of destruction. These are to be seen not only in modern instruments of war but also in the increasing number of victims of traffic and industrial accidents.

Thus we have finally arrived at the stage where the greatest suffering of our times is no longer the result of natural phenomena—as was often the case in the distant past—but almost entirely a by-product of man's own deeds and creations. This has made the tension between nature and mind, between life and machines, a central problem of our time.

Rousseau's cry of "Back to nature!" has become just as meaningless and impossible to fulfill as the "metropolis" dreams of certain American circles. "Back to nature" would mean a betrayal of our history, a reverting to primitive conditions—conditions, moreover, with which modern man is in many respects no longer able to cope. And the metropolis dream come true—the dream of a city of tomorrow where man lives in an entirely artificial, technical environment —would mean a further deterioration of man's mental, moral, and physical health. Under such artificial conditions, all natural instincts and systems would degenerate and disintegrate and would have to be replaced by arbitrary ones. So we see that the path must lead neither to Rousseau nor to "metropolis," whose inevitable fate was already discernible in the Tower of Babel.

All that remains is a middle course—not the "golden mean" of compromise and comfort but a stern, straight middle course. And the first steps of this middle course are indicated by what we call "biotechnics." The Greek word *bios* means "life," and *techne* originally meant "art." The ancient art of the artisan gradually developed into that which today we call "technology" in its widest sense and which, to a large extent, is directly opposed to *bios*, life.

What is biotechnics? It is not the artificial bridging of two contrasts, not a compromise, but a true fusing of two forces. If we compare the earliest aircraft models with the latest pursuit planes, we see at once that, from highly

artificial, complicated constructions, very simple, clear outlines have finally developed, outlines which no longer seem arbitrary but rather in complete accord with the laws of nature. The same is true of machines, motorcars, microscopes, telescopes, ships, and many other things. Machines have taken on organic form: gliders resemble soaring seagulls; airplanes and automobiles are approaching the shapes of insects; and the submarine is unmistakably related in shape to the fish. All this is not coincidence. The organic form is the final aim of all technical designing; for the organic form represents the experience of hundreds of thousands of years. It is the perfect form for its purpose, permitting the ultimate record achievements. Technical science is recognizing this fact more and more clearly. The same applies to the interior construction of machines, of the factory plant, and of engineering in general, which has suddenly awakened to the realization that living nature can provide it with matchless designs.

Today man identifies himself as never before with the creature of his brain, the machine. While in its early stages the railway was regarded with intense suspicion and people entrusted themselves to this new mode of traveling with the utmost reluctance—the same was the case in the development of aviation—nowadays the crew of a dive bomber or submarine is one with its craft, just as a scientist is one with his microscope or even the personnel of a factory with its plant.

Yet all this represents only one aspect of biotechnical developments: only the influx of life into technical work is revealed here. At the same time, however, our machine age is also beginning to make more and more use of life. In the sphere of production a difference has hitherto been made between two sectors: the agricultural and the industrial. In the farmer's association with animals and plants—this also, of course, includes the fisherman and the forester—technical innovations were accepted comparatively slowly. In many respects, agricultural and industrial thought seemed irreconcilable. It was only the agricultural, forest, and fishery products which underwent industrial processing; the living plants and creatures were not affected. However, there is one industry which has always belonged to the biotechnical border zone: the brewing industry. Here we find in the midst of a technical process, under purely artificial conditions, a living fungus—yeast. This living microorganism has thus become the determining agent of a technical-industrial process. So here the disparity between life and machines has to a certain extent been overcome.

This disparity is now being overcome in many other spheres, especially in Germany. Among the indispensable raw materials of modern industry are coal and mineral oil, both substances produced by living organisms. Now the oil and coal reserves of our planet are not inexhaustible. On the other hand, industrial demand for them is constantly rising, so that the exhausting of these reserves can already be foreseen. To find adequate substitutes for these geological supplies is a problem which can only be solved by biotechnics.

This is where the young but very promising science of microbe chemistry appears on the scene. Mineral oil was produced by microbes living in water and using sunlight for building up the substance of their body. German biologists have now succeeded in raising such quantities of diatoms (microscopic algae) on spun glass kept in stream water that an entirely new process of obtaining oil can be based on this, a process which has already passed the stage of scientific experiment and is now being tested on an industrial scale. For diatoms—whose tiny skeletons are the basic element of the diatomaceous earth known as kieselgur—in contrast to most other cellular plants, do not form starch as a reserve substance but oil. And the same diatoms which are now being exploited in a process which is neither purely agricultural nor purely technical in the old sense had a large share in the geological formation of petroleum. Thus biotechnics is now repeating a geological

process and has thereby opened up an inexhaustible source of organic raw material. The fact that this new source is still of minor importance from an economic point of view is insignificant in the face of the fact that the beginning of an extremely promising path into the future has been found.

Other examples of biotechnics are the process of employing a living fungus to transform indigestible peat into an albuminous cattle feed of high value, available independently of climate or season, and the successful experiments on producing sugar from wood by means of microbe chemistry.

But the field of biotechnics is much larger. Wood is being used more and more as an industrial raw material. A growing number of articles of daily use, of fodder substances, building materials, and chemical products are being obtained from wood. This means a considerable saving in coal. However, the increasing demand of the various industries might represent a deadly peril to our forests, especially in densely populated areas. This peril can only be dealt with effectively by biotechnics, whose task it is to develop fast-growing timber. Here is an example of what has been done.

About ten years ago, German experimental stations crossed various fast-growing species of poplar and developed a new variety whose seeds produce shoots which grow to a height of more than one meter within a year. More recently, they succeeded in changing the innate qualities of this new variety by injecting colchicum, the poison contained in the saffron plant—in other words, one more natural product. This poison, twenty milligrams of which are deadly to human beings, is beginning to be used in the treatment of cancer because of its retarding effect on cell division in humans and animals. In plants, however, the poison causes the chromosomes (known to be the carriers of heredity) to double or even treble. The effect of such treatment is an extraordinary speeding up of growth. Thus it was possible to produce record poplars whose seeds grew into shoots three meters high in one year and four and a half meters high in two years. In this way, the production of wood could be immensely increased. Although this particular wood may not be much good as lumber for building purposes, this is of no importance, since what is needed is the raw material wood for use in technical and industrial processes.

This brings us to the vast field of animal and plant breeding as a whole, the biotechnical importance of which has hardly been recognized. We may readily admit today that, without the achievements of German research in this field, Germany's war situation would be a serious one.

But it is by no means true to say that the young science of biotechnics, only a few of whose manifold achievements have been indicated here, gives us the right to rest on our laurels or to indulge in a feeling of superiority toward nature. On the contrary: this vast, hardly begun work enhances our respect and awe of the laws of life, which very laws permit us to increase the effectiveness of some biological processes far beyond the ordinary limits. Any feeling of superiority toward nature which the old-style technology may have entailed, vanishes in the face of biotechnical developments. Life cannot be cheated, the laws of life cannot be circumvented, without man suffering grave harm. But if we learn once again to work and live with nature and in accordance with its laws, we may look with confidence into the future of mankind, a future whose face is new and unfamiliar but nevertheless healthy and open.

Biotechnics is certainly no panacea; but it is one of the strongest indications for the fact that we are on the right road and may look into the coming dawn with confidence.